THE IMPACT OF DDT SPRAYING AND MALARIA TREATMENT ON THE MALARIA TRANSMISSION IN A HYPO–ENDEMIC AREA OF SOUTH KALIMANTAN

S.Gandahusada*, B.Nainggolan**, Putut Djokopitoyo***

ABSTRACT

Dari tahun 1979 sampai dengan 1981 dilaksanakan penelitian epidemiologi malaria di suatu daerah hypo-endemis di Kalimantan Selatan. Sebagian dari penelitian yang dilaporkan di sini, menilai hasil penyemprotan rumah dengan DDT yang dilaksanakan secara rutin oleh Dinas Kesehatan Propinsi serta menilai intervensi yang diadakan atas dasar epidemiologi setempat. Daerah transmigrasi Batutungku disemprot secara rutin dan hasilnya dibandingkan dengan Panyipatan, suatu desa yang tidak disemprot.

Hasil surveillance menunjukkan bahwa incidence rate tiap tahun selama tiga tahun penelitian di kedua daerah turunnya sama : di Batutungku dari 10,2‰ menjadi 8,7‰ pada tahun 1980 dan 5,3‰ pada tahun 1981, dan di Panyipatan dari 16,6‰ menjadi 14,6‰ pada tahun 1980 dan 7,7‰ pada tahun 1981. Fluktuasi kepadatan An. nigerrimus dan An. peditaeniatus, dua species anopheles yang paling banyak tertangkap di daerah penelitian, juga tidak menunjukkan adanya perbedaan di kedua daerah. Dengan incidence rate dan data entomologis ini, dibuktikan bahwa penyemprotan rumah-rumah di Batutungku tidak efektif. Bahwa di kedua daerah incidence rate tiap tahun menurun, disebabkan oleh "radical treatment", yang dimulai di kedua daerah sejak Oktober 1979. "Mass treatment" di dua RW di Batutungku di mana incidence malaria per bulan lebih tinggi daripada lain-lain RW, dapat menekan malaria transmisi.

INTRODUCTION

Since the commencement of the first five year plan in 1969 the Malaria Control Programme (MCP) has gradually been expanded to the outer islands, Sumatra, Kalimantan, Sulawesi, Irian Jaya and other smaller islands. The targets are areas of economic, political and military importance and the objectives are to reduce the malaria morbidity rate to 2% or lower and to eliminate mortality due to malaria. Indoor house spraying with DDT is the primary control measure.

In the last 15 years thousands of Javanese families have been resettled in fertile areas of Sumatra, Kalimantan and Sulawesi to enhance economic growth of the country. These transmigration areas are sprayed with DDT 2 g/m2 once or twice a year depending on the prevalence rate and the financial situation of the Provincial Health Service. Malariometric surveys in these areas show that in many areas the prevalence rate is below 6% (unpublished service reports). But a proper evaluation of the effect of spraying on malaria transmission has never been done. It is the intention of this investigation to study the epidemiology of malaria in a resettlement area, to evaluate epidemiologically the impact of residual house spraying with DDT carried out by the Provincial Health Service, and to take other intervention measures if deemed necessary. This article deals only with the evaluation of the residual house spraying and malaria

* National Institute of Health Research and Development.
** Provincial Health Service of South Kalimantan.
*** Directorate General of Prevention and Control of Communicable Diseases.

treatment, while the malaria epidemiology of the area will be described in an other article.

METHODS

Two locations were chosen for the study: a resettlement area Batutungku and a native village Panyipatan. Indoor residual house spraying with DDT was done twice a year in 1979 and once in 1980 as part of the local malaria control programme, while the native village remained unsprayed throughout the study and served as the control area. The spraying was carried out by the Kabupaten Health Service with locally recruited spraymen, who were trained for a week. No effort was made to improve the quality of spraying for this study.

A malariometric survey in both places determined the endemicity and because of the hypo-endemic situation, in both places malaria was measured by the incidence rate. For this purpose one local man for each area was trained to do surveillance work, i.e. visiting every house once a month, recording births and deaths and population growth, and preparing thick blood smears from fever cases and from persons who have had fever since his last visit.

The thick blood films collected during the week were sent to the provincial laboratory for examination. Till October 1979 no antimalaria drug was used. Thereafter standard malaria treatment was applied to fever cases (presumptive treatment with 10 mg chloroquine base per kg body weight) and to laboratory confirmed malaria cases (radical treatment) in Batutungku and Panyipatan. The radical treatment consisted of chloroquine 25 mg/kg body weight over 3 days and Primaquine 75 mg over 5 days for vivax and 45 mg over 3 days for falciparum cases (adult dose). For children the dosage of Primaquine was reduced according to age and it was not given below the age of one year. It was for ethical reasons that the malaria cases in Panyipatan were also given the radical treatment.

Density of anopheles species was measured by the in- and outdoor human landing rate. All species of anopheles caught were dissected for sporozoites and parity. This entomological work was carried out once a month for 2 consecutive nights with four to five mosquito scouts in every place, Batutungku and Panyipatan. For every place there was only one catching station. Mosquito captures were done from 18.00 to 23.00 hours. Mosquito scouts spent 45 minutes indoors or outdoors and 15 minutes in cattle shelter.

RESULTS

Malariometric survey

The malariometric survey, carried out in September 1978, showed that both places were hypo-endemic. A total of 272 children of 15 years old and below were examined. Four children had a palpable spleen (spleen rate 1.5%) and six had parasitaemia (parasite rate 2.2%).

Residual house spraying.

In March 1979 the fourth cycle of indoor DDT spraying started. This was followed by other rounds of spraying in September 1979 and February 1980. The first cycle was implemented in November 1977.

Particulars of the spraying are shown in Table 1. The average DDT used per house was between

Table 1. DDT spraying in Batutungku *

Cycle	Date of spraying	No. of houses in the area	No. of houses sprayed	No. of people protected	DDT 75% WP used in kg
4	March '79	750	732	3246	302.1
5	Sept. '79	750	714	3174	265.1
6	Febr. '80	750	750	3399	289.3

* Data from Provincial Malaria Office.

371 – 403 grams, and 5 days were needed to cover the whole area of Batutungku.

Surveillance.

The active case detection started in November 1978. There was only one surveillance worker in Batutungku, serving a population of 3289 people and only one in Panyipatan for 1908 people. Batutungku is divided in 8 RW's and Panyipatan in 8 RT's. They finished their rounds in 7 – 10 days at the beginning of each month. Tables 2 and 3 showed the number of new cases per year and other surveillance data for 1979, 1980 and 1981. The annual parasite incidence (API) for Batutungku in 1979, 1980 and 1981 was 10.2‰ (midyear population was 3542), 8.7‰ (midyear population 3905) and 5.3‰ (midyear population 3974) respectively. For Panyipatan the API for the same years was 16.6‰ (midyear population 1928), 14.6‰ (midyear population 1981) and 7.7‰ (midyear population 2062) respectively. Both areas, the sprayed as well as the unsprayed one, showed about the same reduction of the API. The API in 1980 compared to that in 1979 was reduced with 15% for Batutungku and 12% for Panyipatan, while in 1981 this reduction rate if compared to the API of 1979 was 48% for Batutungku and 54% for Panyipatan.

Table 2. Surveillance data of Batutungku

	1979	1980	1981
Population in January	3289	3795	4015
Midyear population	3542	3905	3974 *
Blood smears examined	578	584	645
A.B.E.R. in %	16.3	15.0	16.2
Average B.E.R. in % per month (range)	1.4 (0.6–2.0)	1.2 (0.6–2.1)	1.3 (0–2.4)
No. positives **	36	34	21
A.P.I in ‰	10.2	8.7	5.3
Average P.I. in ‰ per month (range)	0.8 (0–2.0)	0.7 (0–4.1)	0.4 (0–1.7)
No. of *P. falciparum* cases (%)	6 (16.7)	12 (35.3)	4 (19.1)
No. of *P. vivax* cases (%)	30 (83.3)	22 (64.7)	17 (80.9)

* Population count in the last surveillance cycle in November 1981 was 3933 people.
** New cases only.

Table 3. Surveillance data of Panyipatan

	1979	1980	1981
Population in January	1908	1949	2013
Midyear population	1928	1981	2062 *
Blood smears examined	487	405	362
A.B.E.R. in %	25.3	20.4	17.6
Average B.E.R. in % per month (range)	2.1 (0.4–3.6)	1.7 (1.5–1.9)	1.5 (1.4–2.1)
No. positives **	32	29	16
A.P.I. in ‰	16.6	14.6	7.8
Average P.I. in ‰ per month (range)	1.4 (0–3.1)	1.2 (0–2.5)	0.6 (0–5.3)
No. of *P. falciparum* cases (%)	13 (40.6)	10 (34.5)	3 (18.7)
No. of *P. vivax* cases (%)	19 (59.4)	19 (65.5)	13 (81.3)

* Population count in the last surveillance cycle in November 1981 was 2111 people
** New cases only.

Plasmodium vivax was the dominant species in both areas. During the successive years of study the proportion of *P. falciparum* in Batutungku was 16.7%, 35.3% and 19.1%, while in Panyipatan this index dropped from 40.6% in 1979 to 18.7% in 1981.

Although the annual blood examination rate (ABER) dropped from 25.3% in 1979 to 17.6% in 1981 in Panyipatan, yet this index was still higher than the expected target, which was 10%. In Batutungku the ABER was more stable, around 16% during the respective years. All the 8 RW's of Batutungku and 8 RT's of Panyipatan were well covered by active case detection if measured by the number of blood smears collected per RW Batutungku and RT Panyipatan (Table 4). Based on this monthly BER, the ACD was adequate, which implies that the observed incidence figures gave a true or almost a true picture of the malaria transmission. The Health Center and its health posts did not participate with the collection of blood smears of fever cases and treated the cases with antipyretics or chloroquine.

Since October 1979 in Batutungku as well as in Panyipatan, all laboratory confirmed malaria cases were treated by the surveillance worker with Chloroquine and Primaquine using the

Table 4. Number of blood smears collected per RW Batutungku and RT Panyipatan per year for three successive years.

RW/RT	Batutungku			Panyipatan		
	1979	1980	1981	1979	1980	1981
I	69	56	56	42	32	31
II	95	65	79	60	72	48
III	68	85	112	58	49	51
IV	45	50	42	30	33	24
V	71	66	81	55	38	39
VI	69	74	74	49	40	38
VII	57	61	67	83	49	54
VIII	94	123	134	110	92	77
Total	578	584	645	487	405	362
A.B.E.R. in %	16.3	15.0	16.2	25.3	20.4	17.6

standard radical treatment dose of the Malaria Control Programme. The time lag between blood smear collection and radical treatment ranged from a week to three weeks, but more often it was closer to three weeks. The malaria patients living close to the residence of the surveillance worker in Batutungku were daily visited to get the radical treatment, while for those living far away the medicines for the complete radical treatment were left behind with verbal instructions how to use it. As the area of Panyipatan is much smaller than that of Batutungku, the surveillance worker here visited the malaria patients daily to administer the treatment.

Mass treatment.

The malaria cases were not distributed evenly over the RW's of Batutungku. RW VII and VIII had the highest proportion of all the cases detected in a certain time period. From January 1979 to May 1980 17 cases were detected in RW VII and 22 in RW VIII, while in all the other 6 RW's together the total number of cases for the same period was 26. It was for this reason that mass treatment was carried out in these two RW's. The mass treatment consisted of chloroquine (10 mg/kg body weight) and pyrimethamine (1 mg/kg body weight), given once a month for three consecutive months, starting in May to June 1980.

Table 5 shows the population covered, which decreased from 77% in May to 60% in July 1980. Evaluation of this mass treatment consisted of comparing the total cases during an equal time period of pre and post mass treatment, and with the remaining six RWs (Table 6). From January 1979 to May 1980, the pre mass treatment period, the total number of new cases was 17, 22 and 26 (slide positive rate respectively 19.1%, 12.7% and 4.5%) for RW VII, RW VIII and RW I – VI respectively, while for the post mass treatment period, June 1980 to November 1981, this total was 4, 6 and 17 (SPR 4.2%, 3.3% and 2.5%) for the respective areas. These reductions in RW VII and RW VIII were statistically significant with the chi-square test with $p < 0.05$, while those for RW I – VI was not significant with $p > 0.05$.

Table 5. Coverage of mass treatment in RW VII and RW VIII, Batutungku, 1980.

	Number of people covered		
	May	June	July
RW VII (Pop. 443)	307 (69%) *	324 (73%)	274 (63%)
RW VIII (Pop. 534)	445 (83%)	402 (75%)	308 (58%)
Total Pop. 977	752 (77%)	726 (74%)	582 (60%)

* In brackets: % population covered.

Entomological observations.

These observations were implemented for only two years, 1979 and 1980. Fig. 1 and 2 show the combined man-hour density (MHD) of *An. nigerrimus* and *An. peditaeniatus* from in and outdoor human bait collection respectively, for 1979 and 1980 in Batutungku and in Panyipatan. During April and May 1979 no entomolo-

Table 6. New cases before and after mass treatment in 2 RWs of Batutungku and compared with those of the remaining RWs during the same periods.

	Pre-mass treatment			Post-mass treatment		
	1979		1980	1980	1981	
	Jan. – May	June–Dec.	Jan.–May	June–Dec.	Jan.–May	June–Nov.
RW VII	6 (23) *	5 (34)	6 (32)	1 (29)	1 (37)	2 (30)
RW VIII	2 (54)	8 (50)	12 (54)	2 (54)	2 (60)	2 (67)
RW I – VI	9 (215)	7 (202)	10 (166)	3 (234)	10 (198)	4 (253)

* In brackets : the number bloodsmears collected.

gical activities were performed due to administrative problems.

In Fig. 1 the MHD of indoor bait collection of the two species combined was slightly lower in Batutungku than in Panyipatan. However the fluctuation patterns were about the same in both places. The arrows in Fig. 1 and 2 denote the spraying operations. As can be seen from Fig. 1 and 2, spraying operations in September 1979 and in February 1980 did not prevent the increase of the MHD starting in December 1979 and in March 1980 in Batutungku.

The proportion of parous females of *An. nigerrimus* and *An. peditaeniatus* combined was

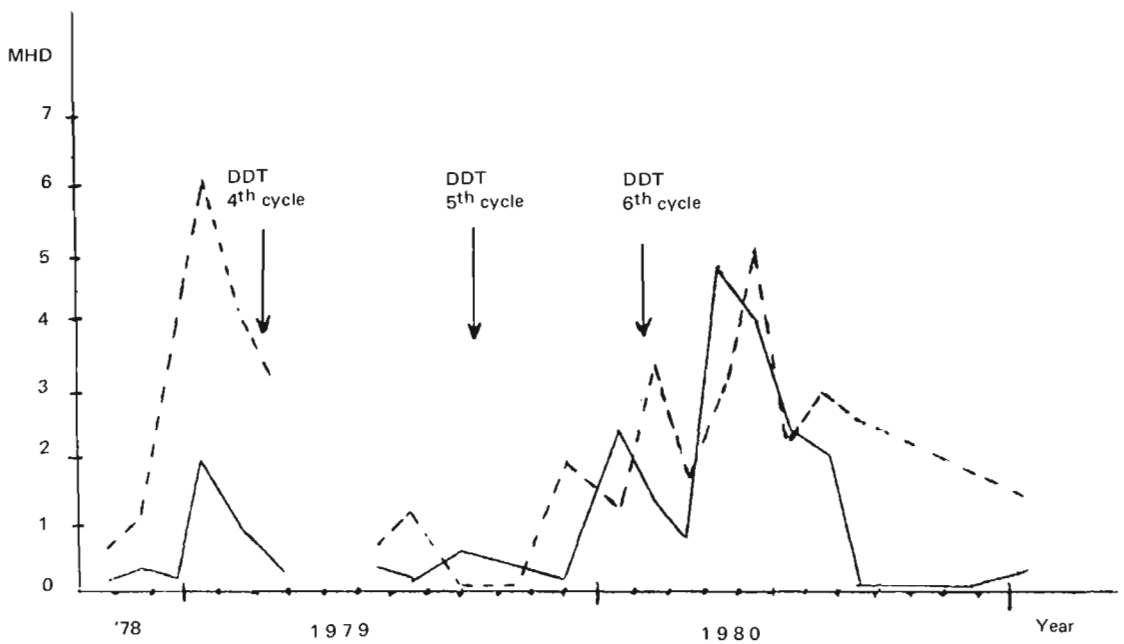

Fig. 1 **The monthly indoor MHD of *An. nigerrimus* and *An. peditaeniatus* combined in Batutungku (———) and in Panyipatan (- - - -).**

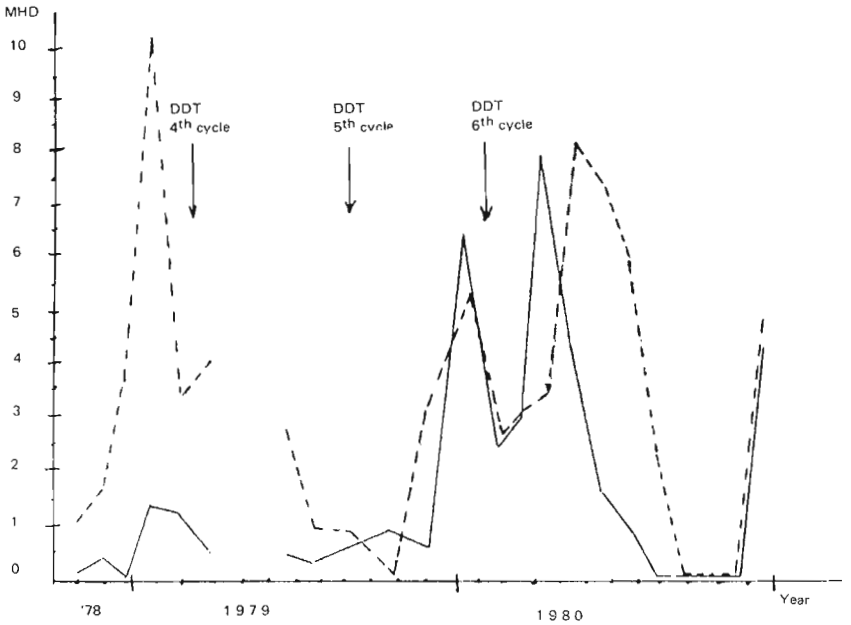

Fig. 2 The monthly outdoor MHD of *An. nigerrimus* and *An. peditaeniatus* combined in Batutungku (.——.) and in Panyipatan (.- — -.).

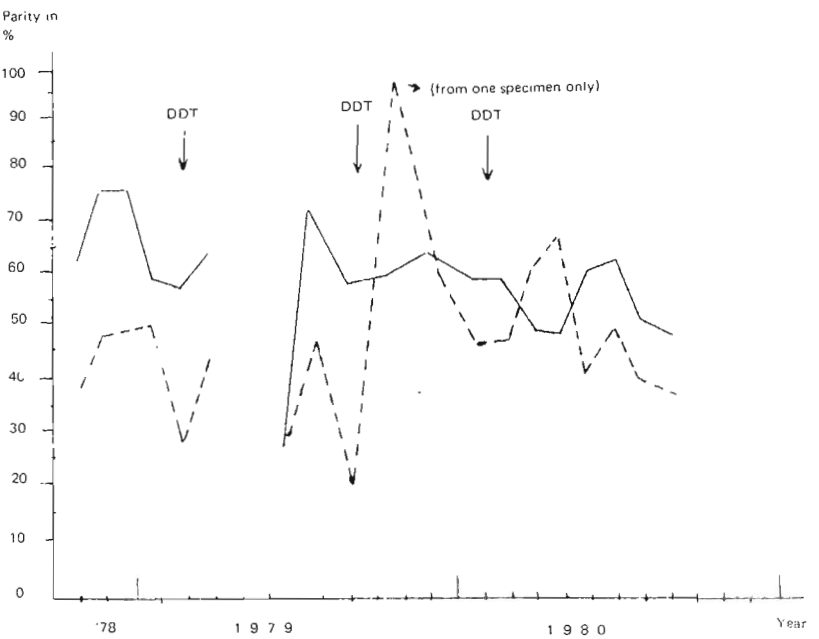

Fig. 3 **The monthly parity of** *An. nigerrimus* **and** *An. peditaeniatus* **combined from in—and outdoor human bait collection in Batutungku (.——.) and in Panyipatan (.- - -.).**

Table 7. Susceptibility test of *An. nigerrimus* and *An. peditaeniatus* in Batutungku to 4% DDT, one hour exposure time, temperature of 25° C and with bloodfed specimen, June 1979.

	An. Nigerrimus			*An. peditaeniatus*		
	No. specimen tested	No. dead	Mortality (%)	No. specimen tested	No. dead	Mortality (%)
Control	26	1	3.8	23	1	4.3
Test	24	22	91.7	24	22	91.7

about the same in the pre and post spraying period in Batutungku. In the control area, Panyipatan, this parity of both species was not much different than in the sprayed area for the same period (Fig. 3). These entomological indices, the MHD and parity, together with the evaluation of the API in sprayed and unsprayed areas give evidence that residual house spraying in this hypo-endemic transmigration area is ineffective.

Susceptibility test with 4% DDT and one hour exposure were done once for *An. nigerrimus* and once for *An. peditaeniatus* in Batutungku in June 1979. The tests with bloodfed specimens showed that both species were still susceptible to DDT with a mortality of more than 90% (Table 7). The true vector or vectors is not known. Over the thousand anophelines composed of various species have been dissected, but not one infected gland with sporozoit has been detected. *An. nigerrimus* and *An. peditaeniatus* were the dominant species in both places.

DISCUSSION

The annual parasite incidence in Batutungku was 10.2% in 1979. Morbidity surveys of transmigrants on their way to their new settlement outside Java have shown that only a few or none had parasitaemia (unpublished report). It is certain that the Javanese population in Batutungku contracted malaria in their new settlement from the time of their arrival at the end of 1977 till the end of 1979, although that area had been sprayed six times from November 1977 up to and including February 1980.

In both places, Batutungku and Panyipatan, the API was about the same; it was slightly higher in Panyipatan than in Batutungku. Considering the total number of new cases in Batutungku from 1979 till the end of 1981 in comparison with that in the unsprayed area, it can be concluded that residual indoor house spraying with DDT has no impact on the transmission. In the sprayed area the number of new cases decreased from 36 in 1979 to 34 in 1980 and to 21 in 1981, but in the unsprayed area the decrease was also of the same order, from 32 to 29 to 16 respectively. This conclusion is supported by entomological data, which do not show a drop in the man-hour density and parity of *An. hyrcanus* group, i.e. *An. nigerrimus* and *An. peditaeniatus*, after the spraying.

The Expert Committee on Malaria in its Technical Report Series No. 272 and No. 324 has set up three criteria for the satisfactory response of malaria to spraying in the early attack phase of an eradication programme.

These criteria are :

1. The drop of *P. falciparum* rate after one year spraying to less than 22% of the original value,
2. The drop of the infant parasite rate to zero and
3. The ratio of heavy infections (parasite count exceeding 1000/mm3 blood) to total infections in the community not to exceed 7%.

These criteria refer to comparison of values

obtained from successive parasite surveys. As it is not clear if such comparison is also valid when data obtained from surveillance are used and moreover if the malaria incidence is low, we did not evaluate along these lines. But comparison of data from the sprayed and the unsprayed area with each other showed that spraying was not helpful. Both areas had a decrease in the incidence of malaria and most probable this was due to presumptive and radical treatment. That to the positive cases in Panyipatan were also given radical treatment, was based on ethical consideration.

Mass treatment, performed once a month for three consecutive months, starting in May 1980 in RW VII and RW VIII, Batutungku, where the transmission was heaviest, succeeded in decreasing the transmission in the second part of 1980, which remained low in 1981. The middle part of the year was chosen for the time of mass treatment, because during this period the parasite reservoir level in the community was the lowest, which was considered as the right time for a mass treatment.

The vector has not been incriminated. Such areas like those in Batutungku and Panyipatan, where malaria is hypo-endemic, are numerous in Sumatra, Kalimantan and Sulawesi. In the past epidemics occurred only if there was a sharp and high increase in the density of one of the potential vectors, i.e. *An. sinensis, An. nigerrimus, An. peditaeniatus, An. barbirostris, An. subpictus, An. barbumbrosus, An. umbrosus, An. letifer, An. minimus* etc. These species are considered to be weak vectors with zoophilic and exophagic behaviour. Such vectors cause refractory malaria (Gabaldon, 1969), an operational term which means that residual indoor house spraying can not interrupt the transmission completely. The method of malaria control for these hypo-endemic areas should be different from the high endemic areas. Health centers with their extended health posts should be strengthened to do not only passive but also active case detection. This active case detection does not need to be performed every month every year. Once the distribution and fluctuation of cases are known, the active case detection can be organized in that part of the year during which the transmission starts increasing. With other words the active detection is not continuously, but intermittent. As such it functions as a tool to prevent the increase of transmission and it provides also information on the malaria situation.

SUMMARY

A study in a hypo-endemic malarious area in South Kalimantan showed that during the year's period of observation, the presently utilized vector control measure, namely DDT indoor house spraying, had no impact on the malaria transmission. It also demonstrated that a simple active case detection and treatment programme could be organized and carried out. This system resulted in reduction of the malaria transmission.

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